DOCUMENT RESUME

ED 061 098 SE 013 566

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TITLE Role-Play and Characterization as Techniques for Teaching Primary Level Number Concepts.
INSTITUTION Bucknell Univ., Lewisburg, Pa.
PUB DATE Apr 72
NOTE 20p.; Based on M.S. Degree, Bucknell University

EDRS PRICE MF-$0.65 HC-$3.29
DESCRIPTORS *Arithmetic; Dramatic Play; *Elementary School Mathematics; *Instruction; Instructional Aids; Kindergarten Children; *Research; *Role Playing

ABSTRACT

This study investigated the effect of play-like behavior on the learning of elementary arithmetic. Kindergarten children from one school were pretested on addition and subtraction of the numbers zero through five; and eight groups of five subjects were randomly selected from those scoring below the mean. These groups were then randomly assigned to four treatments obtained by two levels of characterization with or without role-playing. All groups used a number line with colored houses representing the numbers zero through five. At one level of characterization, the numbers to be added or subtracted were represented by animal figures moving between the houses; at the other level, numbers were represented by numerals in the usual way. The role-playing groups acted out the movements; the other groups only vocalized the results. All treatments lasted for seven sessions. The pretest was repeated as a posttest, and again a week later as a retention test. The results showed that the group using numeral representation without role-playing learned considerably more than all the other groups; an ANOVA confirmed the significance of these differences for the posttest but not the retention test. The authors suggest various explanations for some of the unexpected patterns observed in the results, particularly the uncontrolled sex factor. (MM)

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ED 061098

ROLE-PLAY AND CHARACTERIZATION AS TECHNIQUES FOR TEACHING PRIMARY LEVEL NUMBER CONCEPTS[1]

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Introduction and Purpose

In the literature on games or simulations, the particular variables that the child employs during play have not received the attention necessary to discern exactly what differential effect these variables may have on the learning process. Further, much of the research on games as instructional techniques is either comparative in nature, deals with the use of games for curricular "enrichment" rather than basic instruction, or concentrates on the social or attitudinal outcomes of games.

The purpose of this study was to investigate in the context of an academic task how two variables, here termed role-playing and characterization, affect learning performance. For the purposes of this study, the term characterization describes a process whereby kindergarten age children were asked to personify certain number concepts (0 through 5) either directly by becoming "Number 5" or indirectly by assuming the role of a common animal representing that number. Role-play was an extension of characterization in which the child acted out small dramatic episodes designed to demonstrate certain basic number combinations.

Related Literature

Much of the literature on role-playing is devoted to its socialization aspects. The function of role-playing in the learning process has been treated

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[1]This research was conducted as part of a Master's Degree Program in Educational Research sponsored jointly by Bucknell University and the U. S. Office of Education under provisions of Title IV of the Elementary and Secondary Education Act (The Educational Research Training Program).

The cooperation of Mr. James Baugher, Mrs. Augusta Foose, Miss Ann Witmer and Mrs. Alice Deckard of the Milton Area School District, Milton, Pa., in carrying out this study is gratefully acknowledged.

SE 013 566

lightly. However, role-playing is closely related to the area of simulation and games. Boocock (1968, p. 53) states that in spite of their antiquity and virtual universality, there is a surprisingly small theoretical literature on games. This may be partly because until rather recently, games--and play in general--were considered a kind of cultural residue or luxury item, something a culture could afford after it had taken care of its "real" needs.

Friedman (1971) discusses the attributes of playing games. These are processes (rules, criteria, and values); elements (information, knowledge, and facts); variables (mental and physical needs, skills, and abilities); and a cast of characters who make up the definition of a situation. Friedman explains these attributes as follows:

> Game play is rately devoid of environmental attachments and meaning, rarely an end in itself, rarely fun for fun's sake, never disassociated from individual and societal needs. As an abstracted representation of some segment of reality, game attributes are momentary recreations of some segment of reality attributes, but reduced to controllable dimensions. In order to be a game and not reality, the scale on which the demand of competition, cooperation, role-playing, and accomplishment occur is reduced, permitting the players to handle such demands at their own time, space, volition, and capability levels. This compression of reality speeds up and reinforces learning by making the constituent attributes emotionally comprehensible and acceptable.

Abt (1968, p. 79) feels that educational games use the student's way of viewing things. For elementary school children, educational games translate the child's primarily concrete, intuitive thinking into a sequence of dramatized possibilities that expand his awareness of hypothetical alternatives and fundamental relations. Unfortunately elementary school children tend to concentrate on only one aspect of a phenomenon at a time. This greatly limits their ability to comprehend phenomena with even a few interactions among elements. For Abt, learning from games occurs in three, usually successive, phases as a result of active participation and intense involvement by the subject. These are:

1. Learning facts expressed in the game context and dynamics;
2. Learning processes simulated by the game;
3. Learning the relative costs and benefits, risks and potential rewards of alternative strategies of decision making.

Only a few studies were found reporting significant differences in learning or retention from games. Baker (1968) found that students involved in a role-playing simulation activity learned and retained more information than a conventional class in which the teacher presented historical material, gave reading assignments, and held discussions. The simulation was of the pre-Civil War period and the subjects were assigned the roles of national officials of the period.

Emerick (1970) used a role-playing educational game to evaluate the relationship between learning and levels of student activity and arousal. The three levels of arousal in this study ranged from role-playing of Congressmen to reading of materials to no relevant stimulation. For both the post and retention measures the role-playing groups made significantly fewer errors. Both of these tests measured factual information presented during training.

John (1970) and Austin (1970) researched the relationship between role-playing and futuristic thinking. In both studies role-playing situations that appear in Shaftel and Shaftel's book, Role Playing for Social Values, were presented to the experimental subjects. In the John study the control group was asked to write during the training period while the control subjects in the Austin study conducted map-making sessions. Both studies show that role-playing can serve to increase long range or futuristic solutions.

Studies by Boocock (1966) and Boocock and Coleman (1966) used legislative and career games to determine what type of learning takes place during simulation. Questionnaires presented to the subject indicated that three different types of learning had occurred: the vicarious experience of understanding the process

simulated; factual information; and the development of feelings of greater control of one's environment.

Anastasiow, Sibley, Leonhardt, and Borich (1970) worked with kindergarten children to compare guided discovery, discovery, and didactic teaching. The materials used were pre-number ideas. The researchers found that for simple associations rule-example is the most efficient method but for more difficult interactions a guided-discovery method is best.

According to Sutton-Smith (1971), there are four activities of play in childhood: exploration, imitation, testing, and world construction. Exploration and imitation are self-explanatory. By testing, Sutton-Smith refers to those activities that enable the child to learn about his environment, such as the discovery that fire will burn if touched. World construction gives the child the opportunity to organize his play activity into specific simulations.

Role-playing and characterization are essential attributes of at least two of the play types mentioned above, i.e., imitation and world construction. This study concerns the function of role-playing and characterization as facilitators of formal learning processes in young children.

Procedure and Hypotheses

Subjects

Kindergarten children from the Milton Area School District, Milton, Pa., were pre-tested on their ability to handle binary addition and subtraction problems of the digits zero through five. The problems were presented on five by eight cards to individual students. Students who scored at or below the mean ($\bar{x}$ = five out of twenty possible) were used as possible subjects. From this population, eight groups of five subjects were randomly selected according to class membership. The groups were then randomly assigned to one of four treatments such that each treatment consisted of two groups of five subjects (N = 10).

An analysis of variance showed that there was no significant difference between the four treatment groups according to their performance on the pre-test.

Materials

Two sets of stimulus materials were developed for this experiment. The first consisted of six animal characters cut out of colored cardboard used to represent the digits zero through five. A white strip of cardboard served as the street which represented the number line. The white strip of cardboard supported cut out cardboard houses. These houses matched in color the animal character who was the occupant of the house. Each of these houses was given a number, but this number did not appear on the house.

The second set of materials consisted of the digits zero through five cut out of colored cardboard. The color of each of the digits matched the color of the character cut-out in the first set of materials. The same white strip served as the number line. The number line supported five by eight cards that had the digits zero through five printed on them.

Design

The treatment given the various experimental groups is summarized in Figure 1, below.

Figure 1

Design of Treatments

	Character-number as Concept	Number only as Concept
Role-Playing	T1	T3
No Role-Playing	T2	T4

Procedure

Seven training sessions were administered to each group; each testing twenty minutes. Each treatment covered the same basic concepts with only the approach being different. The groups (T1 & T2) using the character set of terials were given background information to familiarize the subjects with the haracters. During the first treatment session the experimenter explained that

the animals lived on Animal Lane and each house on this street had a house number just like any street.

After the subjects had been familiarized with the characters, the experimenter demonstrated the concept of addition by having two characters move together. This required that two characters move up the street (movement in a right-handed direction) to another house. Subtraction was represented by a character moving out of a house (movement in a left-ward direction) down the street. Each character (number) was the main concept of a training session.

Treatment one employed a role-playing technique. Each subject became a character and acted out the movements required of the addition and subtraction combinations. Treatment two did not experience role-playing. They were required to only vocalize the results of the moving together or moving away combinations.

Treatment three and treatment four employed the numbered set of materials. The first session was to familiarize the subjects with the numbers. The number line was used to define addition and subtraction for these groups. Movement to the right on the number line indicated addition, while subtraction was represented by a movement to the left. Treatment group three was a role-playing group, in that, the subjects became a "number" during the training sessions. Each addition and subtraction combination was acted out by the subjects.

Treatment group four, like treatment group two, only vocalized the results of the addition and subtraction combinations.

Twenty-four hours after the last training session the post-test was individually given to the subjects. The post-test consisted of forty binary addition and subtraction problems of the digits zero through five. Twenty of these combinations had appeared on the pre-test. One week later a retention measure of same forty combinations was given to the individual subjects. Teachers had

been asked not to teach addition and subtraction facts during the training period and during the interval between post and retention testing. During both post- and retention tests each subject was given ten seconds to respond to each combination. Two different female experimenters read the combination to the subject twice before the subject was to respond.

Analysis of Data and Hypotheses

A two-by-two analysis of variance was used to assess the results of the post-test and the retention test. Both analyses considered these variables:

1. Types of activity (role-playing vs. non-role-playing)

2. Presentation of concept representation (character vs. number).

Following the two analyses, differences, where significant, were examined using the Newman-Kuels procedure. For statistical analyses and interpretation the following null hypotheses were stated:

Hypotheses

1. There will be no significant differences in the mean number of correct responses on the post-test between those subjects involved in role-playing and those subjects not involved in role-playing.

2. There will be no significant differences in the mean number of correct responses on the post-test between those subjects exposed to the character representations of the concepts and those subjects exposed to the number representation of the concepts.

3. There will be no significant differences in the mean number of correct responses on the retention measure between those subjects involved in the role-playing and those subjects not involved in role-playing.

4. There will be no significant differences in the mean number of correct responses on the retention measure between those subjects exposed to the character representations of the concepts and those subjects exposed to the number representations of the concepts.

Findings

Post-test

To compensate for the absence of one subject, a two by two analysis of variance with unequal cells was performed on the post-test. The results of this

analysis led to rejection of the first null hypothesis, at the .10 level, of no significant differences in the mean number of correct responses between the role playing and non-role-playing subjects.

Insert Table 1 about here

The second null hypothesis failed to be rejected since no significant differences were found in the mean performance of subjects presented with character representations of the concepts versus subjects presented with number presentation of the concepts.

This analysis also indicated an interaction between treatment and form of presentation of concept significant at the .05 level. A Newman-Keuls analysis indicated that the mean for T4, the number representation of concept group, differed significantly from the means of the other three groups. No other difference was shown among T1, character representation of concept with role-playing; T2, character representation of concept with no role-playing; and T3, number representation of concept with role-playing. The results of the Newman-Keuls procedure may be found in Table 2.

Insert Table 2 about here

Retention Test

Retention test data was similarly treated using analysis of variance. A summary of this analysis may be found in Table 3.

Insert Table 3 about here

The results indicated no significant difference in the mean number of correct responses for the subjects who participated in role-playing versus those subjects

who did not participate in role-playing. Therefore, the third null hypothesis failed to be rejected.

The fourth hypothesis of no significant difference in mean performance by those subjects exposed to the character representation of the concept and those subjects exposed to the number representation of the concepts was rejected at the .05 level of significance.

A significant interaction effect was observed between treatment and form of presentation of concept. A second Newman-Keuls Analysis was run to identify the sources of significance. The only significant difference was between T2, character representation of concept without role-playing, and T4, number representation of concept without role-playing. This difference was due to the decline of retention on the part of T2 rather than any gain on the part of T4. Both T1, character representation of concept with role-playing, and T3, number representation of concept with role-playing, improved from post- to retention tests. The Newman-Keuls Analysis is summarized in Table 4.

Insert Table 4 about here

All trends from pre- to post- to retention-tests are summarized via a line graph. (Figure 2).

Insert Figure 2 about here

Discussion

The groups involved in either character representation of the number concepts or role-playing or both (i.e., T1, T2, and T3) did not perform as well as the group with number representation of the concept without role-playing (T4). Although the pre-test measure showed no significant difference among the groups at the onset of the experiment, there still remains the question of a possible

native superiority of T4 in their ability to handle numerical concepts. No intelligence measures were available to test this possibility.

Since the sex variable was not controlled in the randomization process, the composition of the groups in terms of this characteristic may have had some effect on the learning outcomes. Both sexes were equally represented in only T4 (five male and five female). Seven males and three females composed T1. Males also outnumbered females in T3 (six males and four females). The only group to be predominately female was T2 (two males and eight females). The performance of this group might have been affected by the sex variable since their performance regressed appreciably from post-test to retention test. All of the characters introduced to this group were given a masculine orientation. The masculinity of the characters may have had a detrimental effect on the retention of the concepts by the groups.

Schild (1968, p. 95) has stated that to succeed in a game the player must know not only his own role, but also the other roles: their goals, resources, and constraints. If this statement is true, then the subject involved in a role-playing simulation must handle not only the actual concept being presented but also the rules of behavior during the simulation and the positions of the other subjects. This information load is again complicated when the subject must interpret the relationship between the character representing the concept and the concept itself. In this study, each group has a somewhat different information load to process in terms of acquisition and retention.

T1 would seem to have the greatest amount of information to process. The subjects of this group had to learn the relationship of the character to the concept, the relationships of the combinations of characters to the concepts, the relationship of the street line to a number line, and the rules which governed the combination of characters. Complicating the learning process further was the movement involved in role-playing.

The group with the second largest information load would be T2. This group had to process all of the relationships that T1 was required to process, but this group did not have the added complication of role-playing. The third group with respect to amount of information required to be processed is T3. There was no need to form a relationship between the concept and the number representation of the concept since they were the same. The rules governing the combinations of the digits were not complicated by a street line, instead the number line clearly showed the digits involved. The learning process was complicated, however, by the movement involved in role-playing.

Clearly the group with the least information to process was T4. Due to the equalization of time and the lack of complications of either characterization or role-playing, this group had the opportunity to practice the combinations of the concepts with more frequency than did either of the role-playing groups. T1 and T3 used more time to set up each combination because of the actual physical movements by the participants. Time was also a consideration for T2 since each combination required more processes than a combination for the subjects of T4. T2 subjects had to discern which digit each character of the combination represented and which digit was represented by the correct character response.

Subjects in either of the role-playing groups, T1 and T3, received information from more channels than did the subjects of the non-role-playing groups, T2 and T4. Traver et al. (1964) defines a channel as the media which carry the transmission of information from the source to the receiver. For the subjects of T1 and T3 the channels would include the visual, auditory and haptic systems. T2 and T4 subjects are limited to the channels involving the visual and auditory receptors. Although it would seem that the adding of channels would aid in information processing, this is not always the case. Each channel has a certain

capacity for transmitting information while keeping the number of errors to a minimum. Channel capacity is not additive. Each additional channel does not increase the efficiency of judgment by an increment equal to the channel capacity. Instead, as shown in an experiment by Pollack (1953, p. 327), the addition of dimensions that vary does augment the channel capacity for making absolute judgments, but not to as high a degree as one might be led to expect judging from the capacities of the individual channels alone. Therefore, each additional dimension adds a decreasing increment to the channel capacity. People are less accurate in any one dimension if they must judge more than one attribute at the same time (Travers 1964). Due to the additional channels involved in the presentation to T1 and T3 their performance may be explained via informational theory in that the amount of information required to be processed by the subjects of these groups may have reached the capacity level for children of this age group.

Another possible explanation of the findings may be in the work of Bourne and Haygood (1959)(1961). In a series of experiments they studied concept formation as a function of variables suggested by information theory. As they increased irrelevant information, the reinforcement of irrelevant information and intradimensional variability they found corresponding decreases in performance. Partial support for the preceding statement can be found in the study of Anastasiow, Sibley, Leonhart, and Borich (1970). This study introduced kindergarten children to pre-number concepts via three methods of instruction, i.e., guided discovery, discovery, and didactic teaching. For simple associations the didactic method was most efficient, while for the intersection of multiple dimensions the guided discovery approach was the most efficient. The didactic teaching method involved a rule and an example which would eliminate many irrelevant variables. The role-playing groups T1 and T3 were exposed to more

irrelevant variables than T4. The method of presentation for T4 not only permitted more time for practice of the combinations but also eliminated many irrelevant variables which again according to information theory would enable T4 to perform more successfully than the role-players on an immediate measure of achievement.

Although T4 appears to have attained more information on all measures, the improvement of T3 on the retention measure suggests a continued improvement in retention for this group. If a second retention measure had been administered, the question of a continuance in this trend might have been answered as demonstrated in Figure 3.

Insert Figure 3 about here

Information theory provides an explanation for the performance of the four goups on the post-test, but the improvement of T3 on the retention measure seems to contradict information theory. The manner of presentation for T3 may have had a greater novelty effect with a subsequent increase in attention and recall. Another trend should also be noted from this figure, that of the regression of T2. As discussed before, this may be due in part to the sexual composition of the group.

Suggestions for Additional Research

The statement by Sutton-Smith (1971) that until we know exactly what goes on during play, we are interfering with the child's own learning process emphasizes the need for further research in this area. Many other variables are present in play activities besides those investigated in this study. One of the four types of play mentioned by Sutton-Smith is testing. The question of how the child tests his own hypotheses and how he decides which hypothesis to test may be particularly valuable areas of investigation.

The next step in the extension of this study would be to test the predicted trends of retention in relation to other related variables such as intelligence or mathematical ability. The regression of the predominately female group on the retention measure, suggests that some consideration be given to the sex of the subjects in assignment to treatments. The length of the experiment and the novelty of having a different adult figure in the classroom may also affect the results. As with most experiments, a larger population receiving the treatments for a longer period of time would add to the reliability of the findings. If the treatment could be incorporated into the regular classroom activity, the novelty of the experimental situation would be minimized.

Role-playin_ seems to have a positive effect on the retention of concepts. If this procedure could be integrated into more conventional methods of presentation, this combination might prove to be the most effective for acquisition and retention of number concepts among young children.

Table 1

2 x 2 Analysis of Variance with Unequal Cells--Post

Source	SS	df	MS	F	P
A (Role-playing vs. non-role-playing)	48.2875	1	48.2875	2.8341	*
B (Form of concept)	40.0064	1	40.0064	2.3481	n.s.
Interaction	72.3992	1	72.3992	4.2492	**
Error	596.3223	35	17.0377	—	—

* $p < .10$
** $p < .05$

Table 2

Newman-Keuls Analysis of
the Mean Scores for the Treatment Groups--Post

Source	T1	T2	T3	T4
Treatment	7.3	6.8	6.6	11.5

Note: Significant interactions are designated by double arrows (----). Newman-Keuls Analysis--.05 level.

Table 3

2 x 2 Analysis of Variance--Retention

Source	SS	df	MS	F	P
A (Role-playing vs. non-role-playing)	732.6	1	4.9	.2407	n.s
B (Form of concept)	96.1	1	96.1	4.7223	**
Interaction	78.4	1	78.4	3.8525	*
Error	732.6	36	20.35	—	—

* p< .10
** p< .05

Table 4

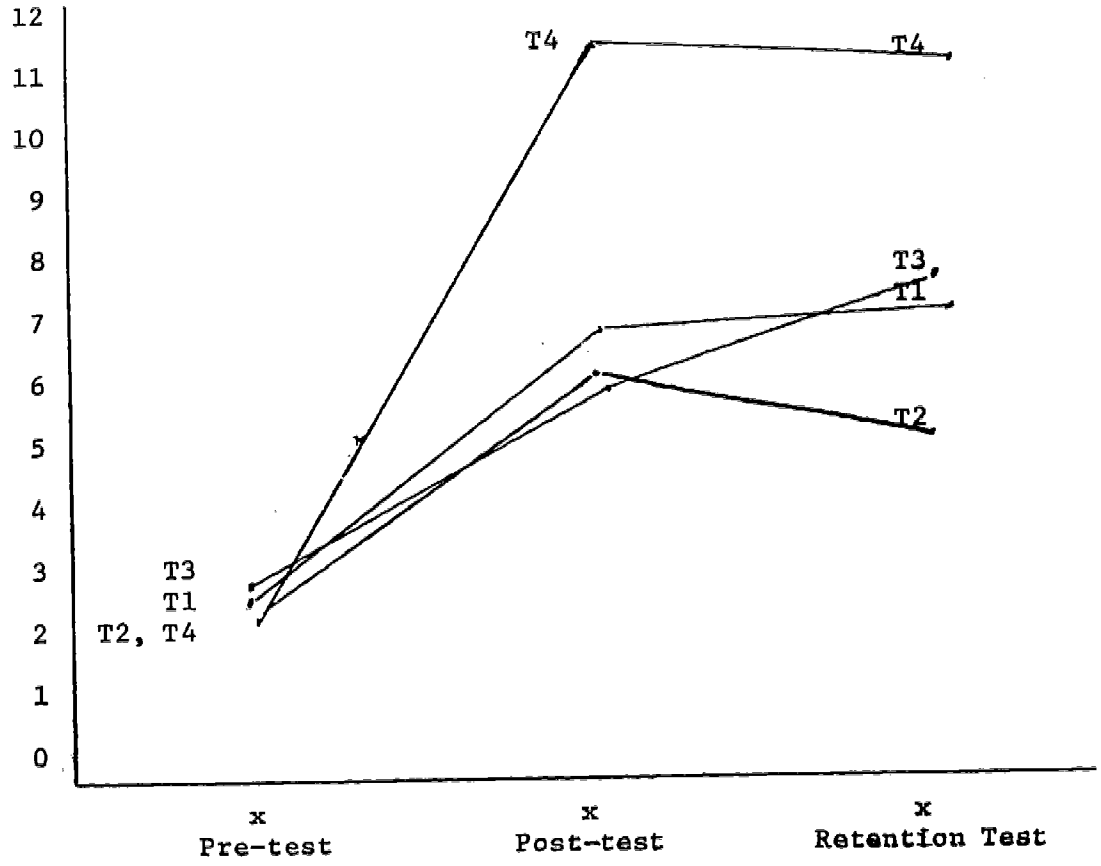
Newman-Keuls Analysis of the
Mean Scores for the Treatment Groups--Retention

Source	T1	T2	T3	T4
Treatment	7.5	5.4	7.8	11.3
		⟷		

Note: Significant interactions are designated by the arrow (⟷). Newman-Keuls Analysis--.05 level.

Figure 2

Graph of Performance on Pre-, Post-, and Retention Tests



T1--Character representation of concept with role-playing.

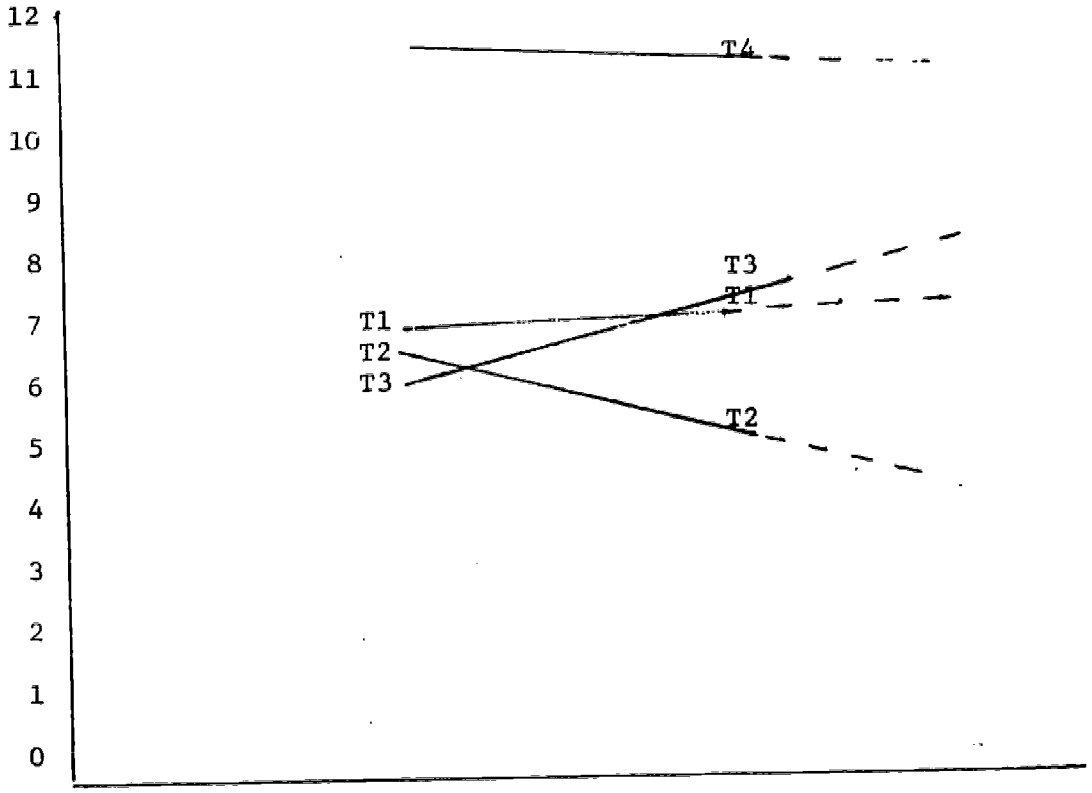
T2--Character representation of concept without role-playing.

T3--Number representation of concept with role-playing.

T4--Number representation of concept without role-playing.

Figure 3

Possible Retention Trends By Treatment Groups



---------- = Possible Performance

_____ = Actual Performance

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